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PLAINS AND PENEPLAINS OF AUSTRALIA

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1. DEFINITION OF TERMS

In order to obtain a clearer idea of the geographical features here dealt with, it is necessary in the first place to consider the generally accepted definitions of plain and peneplain, and to compare them with the Australian conception of those terms. For the different continents have different characteristics, and definitions applicable, say, to European conditions will not fit exactly in the case of Australia.

A "plain" has been defined as an extensive stretch of land with a few inequalities of surface only, and a "peneplain" as an area which has been worn by streams and wind action almost to the level of the ocean, sea, or lake into which the streams of the area discharge. Hence a peneplain may be a high plateau, or it may be a surface near sea level, but it is almost a "plain."

In Australia, connotation of the term "plain" is somewhat elastic. It may have reference to an area of great size, level almost to the point of monotony, and covered in many places with growths of timber so dense as to cause travellers to mistake their way. Here and there open spaces of variable size and covered with grass, or herbs, stand out in striking contrast to the areas of dense timber surrounding them. The great North-western Plains of New South Wales, for example, extend from the foothills of New England to the Darling or Barwon River, with practically negligible irregularities in their topography. For many miles the traveller may pass through dense and high growths of belah (**Casuarina Cambagei**) or brigalow (**Acacia harpophylla**). Here and there open grass or herb lands occur, varying from 100 yards to 10 or 20 miles in diameter. These open spaces are known also as "plains." Fine examples are the Old Man, Tycannah, and Edgeroi Plains.

The great "Riverina," and the North-western district of Victoria furnish other fine examples, as also the country west of the plateaus in southern and central Queensland.

In the plateau country of Eastern Australia a rolling surface, either treeless, or with comparatively few trees, is known as a plain. Good examples are the Darling Downs, the plains of New England, the Bathurst, Goulburn, Yass, Monaro, and Omeo Plains. Small open spaces in areas of heavy forest or jungle are also called plains, such as the Paddy's and Little Plain in the Dorrigo jungle, The Little Manning Plain, and so on. Basaltic and slate areas in the high plateaus sparsely

covered with trees, and clothed with dense coarse grass growths, are also known as plains, such as Kelly's Plains, in New England (Tantangra, Twelve Mile and others), The Flour Bag, Cobungra, Dargo, and the Bogong High Plains in Victoria.

These plains, so called, are plateaus, and the Bathurst, Goulburn, and allied types, have the appearance of wide valley floors with undulating surfaces, hemmed in on two sides, at least, by plateau remnants, and such upland "plains" or plateaus pass into areas of forest without losing their main topographic features. If followed far enough downstream they merge either into the inland plains of denudation or accumulation or they terminate in wild ravines, separated by ridges rising, generally, to similar heights.

To the Riverina, the North-western Plains of Victoria and New South Wales, and similar areas elsewhere in Australia, it is proposed to apply the term "plain." To the mountain or foothill type it is proposed to apply the term "peneplain" or "upland plain."

In this article, therefore, a plain is taken to be an extensive area, approximately level, not raised much above sea-level, forming open land in places, but covered with forest or "scrub" over large areas.

A "peneplain" is defined as an extensive area of plateau or low land with undulating surface, bounded by plateaus or plateau remnants, the latter rarely rising as much as 2,000 feet above the "peneplain" at its base.

The peneplains of Australia have no exact counterpart in any other country.

2. GEOGRAPHICAL DISTRIBUTION OF PLAINS AND PENEPLAINS IN AUSTRALIA

Broadly considered, Australia may be said to have a plateau periphery, varying both in width and height, but broken at the place where the drainage of the Murray basin passes to the sea.

This plateau periphery is widest in Western Australia and narrowest round the East Australian coast from Thursday Island to the neighbourhood of Stawell in Victoria. Its greatest heights are to be found along the relatively narrow eastern and south-eastern portions, while the great plateau of Western Australia has only a low average height. The explanation of this feature is suggested later.

Australia, however, may be regarded in another way, namely, as consisting of three portions - Eastern Australia with a peripheral ring of high and relatively narrow plateaus; Western Australia consisting mainly of a low broad plateau; and a third portion relatively low in height, separating Eastern from Western Australia. This central zone is bordered on the north by plateaus or rising ground from which the Diamantina and associated streams in part take their rise.

North and East of Australia lies a zone of sea or sunken land subparallel to the trend of the associated coast of Australia. Thus the Tasman, Coral, and Javan, seas, on the side distant from Australia are bordered by belts of narrow and very high plateaus, now in part dissected by streams. Good examples of these plateaus are the Alps of New Zealand, the snow-clad ranges of northern New Guinea, and the Javan plateaus.

A fivefold arrangement of plateau and sunken area may therefore be made.

1. A low broad plateau forming the south-western and western portion of the Australian continent.
2. A sunken centre, drained by the Diamantina and Murray river systems.

3. A narrow ring of high plateau, discontinuous in places, from Thursday Island through New England, Monaro, and the Victorian Alps, to the Grampians.
4. A deep sunken area occupied by the Tasman, Coral, Arafura, and other seas and islands.
5. A series of rings of **very high** plateaus associated with active volcanoes, from New Zealand to Java.

This fivefold division may be reduced by future observers to threefold, the sunken area of Australia being taken as one feature and the peripheral plateaus as one feature also.

It may here be noted that the easterly rings of plateaus have suffered much from denudation, and the waste so derived has been deposited partly in the central area of drainage and the peneplains or plateaus. Traced backward the gorges may be seen to head in the plateaus separated therefrom by high waterfalls or successions of cascades, while the narrow ridges bounding the ravines merge on both sides into the massive plateau itself.

Inland again lie the great plateau remnants, such as those traversed by the railway at Mt. Lofty, Petersburg, Ballarat, The Kilmore Gap, Monaro, Hilltop to Yass, the Blue Mountains to Orange, New England, the Darling Downs and Barron Falls to Mareeba.

The High Plains of Victoria, the Kosciusko Plateau, Kiandra, and Guy Fawkes, are magnificent examples also of the plateaus or peneplains in Eastern Australia.

The plateau surface, so far from being level, consists of a series of very broad valleys surrounded by other plateau masses. These valley surfaces are undulating and occur at heights above sea-level varying from 100 to 6,500 or 7,000 feet. They appear to have been excavated within a former plateau of variable but low altitude. Instead of forming a vast unbroken surface like the Riverina they are composed of many independent but branching valley systems, the valleys being of great width and separated by low divides varying in height. The whole area has the appearance of a series of plains in the initial stage which have been near sea-level and which have been pushed gently upward so as to maintain their continuity with the old inland surface.

The inland drainage has cut deeply into this plateau surface also.

The larger portion of the inland area of both Eastern and South Australia is a low peneplain rarely exceeding 500 feet in height above sea-level, but it has the appearance of a plain more than the raised peneplain of Eastern Australia. The explanation is supplied in 4 **infra**.

In this description much of the central peneplain is included with the Inland Plain of denudation. Fine examples of these peneplains occur within, and in the neighbourhood of, the Great Australian Artesian Basin, the Nullarbor Plains, the South-east of South Australia, the North-west of Victoria and the district to the South and South-east of Darwin.

These lowland peneplains of the inland areas may be covered with pebbles, either of residual or later concretionary origin, long parallel ridges of sand 200 to 1,000 yards apart and 10-50 feet high, or with clay pans, blown dust, or alluvium.

Within the great peneplain areas of the central and southern portions of Australia which have not been raised much above sea-level, the Diamantina, Murray, and Darling River systems have formed enormous plains of accumulation, in places monotonously level. They are frequently composed of deep rich black, reddish, or grey soil, as, for example, along the great Diamantina, Murray, and Darling streams.

Plateaus or faulted and warped peneplains raise their heads abruptly from some of the central plains. Examples of these are the Barrier Ranges of Broken Hill (mentioned by Benson) and the Mt. Lofty and other ranges in South Australia.

Splendid examples of plains of accumulation are the Riverina, the Black and Red Soil Plains along the great rivers, the North-western plains of New South Wales, the plains of central and southern Queensland, the plains (Mundi Mundi, Willangee and so on) stretching north-westerly from Broken Hill into South Australia, the Adelaide Plains, the Spencer's Gulf Plains, the Willochra Plains and the plains southerly and easterly from Darwin.

Sandy and calcareous plains occur also in the more southern and eastern portions of South Australia, while the Adelaide Plains and the Port Pine Plains are good examples of the coastal plains type.

In the central area it may be stated broadly that the plains coincide more or less with the area occupied by the artesian and sub-artesian basins, such as the Great Artesian Basin, the Murray River Basin, the Nullarbor Plains, the Adelaide Plains, and the plains bordering Spencer's Gulf.

The large sub-continent of Western Australia consists mainly of a low plateau, especially in the central and south-western portions, bordered with coastal plains. The Nullarbor Plains extend also from South Australia into Western Australia.

3. PRINCIPAL PLAINS AND PENEPLAINS OF AUSTRALIA

A list of some of the well-known plains and peneplains in Australia is given hereunder:-

A. Peneplains

1. The Eastralian Peneplain (figures supplied herewith are approximate average heights above sea-level) -

- (a) The Bellenden Ker or Stannary Peneplain (1,500-2,800 feet).
- (b) The Charters Towers Peneplain (1,000-1,200 feet).
- (c) The Mount Morgan Peneplain (1,000-1,400 feet).
- (d) The Darling Downs (1,000-2 000 feet).
- (e) **New England** (including Tenterfield (2,800-3,000 feet), Ben Lomond (4,300-4,500 feet) or Guyra, Glen Innes (3,500-3,700 feet), Guy Fawkes (4,200-4,600 feet), Armidale (3,200-3,500 feet), Walcha (3,500-3,700 feet), Tomalla (4,000-4,500 feet), and Barrington (4,000-4,500 feet) peneplains.
- (f) **Central Tableland**, including Blue Mountains (600-4,000 feet), Sunny Corner (3,500-4,000 feet), Hill End (3,000-3,300 feet), Bathurst (2,100-2,700 feet), Orange (2,800-3,200 feet), Goulburn (2,100-2,500 feet), Yass (1,600-2,000 feet), Moss Vale (2,200-2,400 feet), Braidwood (2,200-2,400 feet), Breadalbane (2,200 feet), Crookwell (3,000 feet), and Tomago (2,200 feet) peneplains.
- (g) **Monaro**, including Cooma (2,700-2,800 feet), Kiandra (4,500-5,000 feet), Kosciusko (5,000-6,500 feet), Bombala (2,500 feet), Nimitabel (3,500-3,700 feet), and other peneplains.
- (h) **Victorian High Plains**, including Omeo (2,100-2,400 feet), Dargo (4,500-5,000 feet), Cobungra (5,000-5,500 feet), Bogong (6,000 feet), Ballarat (1,500-1,800 feet), and other peneplains.

2. Barrier Ranges of Broken Hill (1,000-1,400 feet).

3. **Great Lowland Peneplain** of the more central portion of Australia (250-1,000 feet).

4. **South Australian Highlands**, of which the Mt. Lofty (1,000-1,500 feet) and Petersburg peneplains (1,000-2,000 feet) are types.

5. **Northern Territory Tablelands**. Barkly Tableland may be taken as a type. A lower peneplain appears to be associated with these low tablelands.

6. **Westralian Peneplain**. The Darling, Kalgoorlie, and other peneplains, mentioned by Jutson, may be taken as types. Most of these peneplains have co-extensive surfaces. According to Jutson they vary mainly between 1,000 to 2,000 feet above sea-level with an average of 1,250 to 1,500 feet.

B. Plains

1. **Coastal Plains** less than 200 feet above sea-level from Thursday Island to Camperdown in Victoria. These are small and scarcely deserve specific rank. Most of them, as the Hunter Plain between Newcastle and Maitland, are areas which have been recently submerged, then silted to, or near to, sea-level, and which now lie a few feet above sea-level by reason of recent land emergence.

The Emu Plain is a small type of the plain of accumulation along the Nepean River near Penrith which has been deposited by the Nepean River, under the shelter of the monoclinal fault of the Blue Mountains.

The coastal plains of Western Australia and of South Australia, such as The Swan, Spencer's Gulf, and Adelaide plains are types of plains of accumulation lying at the feet of fault, or warp, scarps of late geological age.

The large coastal plains of Northern Australia appear to be similar to those of Eastern Australia, only on a much greater scale.

2. **Interior Plains** (less than 800 feet above sea-level) -

(a) Great Central and Southern Queensland plains. These are partly plains of accumulation and partly peneplains.

(b) Plains of the Bulloo, Copper and Diamantina.

(c) Great North-western plains of New South Wales. These also in the north-eastern portion merge into peneplains.

(d) Great Central plains of New South Wales (300-800 feet).

(e) Riverina (less than 600 feet above sea-level).

(f) Darling River plains (less than 400 feet above sea-level).

(g) Murray Basin plains in south-eastern corner of South Australia.

This is in great measure a peneplain formed from an old plain of accumulation.

(h) Broken Hill plains, including Mundi Mundi, Willangee, and other plains.

(i) Nullarbor plains (these might be classed as a lowland peneplain or plain of denudation).

4. **ORIGIN OF PLAINS AND PENEPLAINS**

For a long period of time Australia has been isolated from the other great land blocks of the

world, and there are strong indications that this isolation was effected about the time when the chalk of England was deposited. The great ocean basins then became overfull and spilled over the lower portions of the continents, thus forming enormous continental seas. The sea which crept into Australia occupied much of the area now known as Queensland and New South Wales, as well as portions of South Australia and the Northern Territory. There is reason to believe, also, that this great sea extended from the Malay Archipelago to the Southern Ocean, thus cutting Australia into an eastern and a western portion.

Both before, and during, the period of encroachment of the land by the ocean, the continents were being worn down slowly towards sea-level by the weather and by streams. In this way the Eastern and Western Australian land surfaces were converted into peneplains raised but very little above sea-level. A similar condition of affairs obtained in New Zealand, New Guinea, and other lands to the north of Australia.

This period of sea extension and of peneplanation was closed by a period of mountain-making along the zones indicated by the rings of islands surrounding Australia to the north and east. The effect produced was as if a gigantic force had been directed against Australia from the south-east, the east and the north, but a force which had met a buffer of great strength interposed between it and its objective. High plateaus and fold mountains were formed in rings around the buffer. The force appeared to travel in wave fashion, and Hedley suggests that the Tasman and Coral seas mark a trough of the movement. The next crest of the movement is indicated by the eastern periphery of Australia. This, however, was a much-diminished crest. Central Australia marks the next trough, while the Westralian Plateau marks some movement still weaker, but wider and more general.

The plateaus and ranges under consideration did not grow at once to their present heights. The earlier types were low in altitude, and long periods of still-stand of the land and subpeneplanation occurred between the periods of **revival** of uplift. In this way the present peneplains were formed.

Finally came a great period of mountain making, or rather, a revival of the old mountain making on a gigantic scale. The great Alps of New Zealand and New Guinea were formed, and the younger Eastralian peneplain was raised in sympathy, but variably, so as to form the present Blue Mountains and all the Eastern Highlands. The Westralian peneplains of much less altitude were also hoisted at this time to form the present plateau.

During the same period the central area of Australia had been sinking. Far below sea-level, the old land surface sank unequally, forming the famous Artesian basins of Australia. As the land sank the old basins were filled gradually by the outwash from the surrounding plateaus. In this way were laid the foundations of the great central plains of the present time. In the north, however, these old plains had been raised well above sea-level at least once.

After the time of the great elevation, now known as the Kosciusko Period, the streams ran much more swiftly than heretofore because of the steepening of their channel slopes, and the great river systems had therefore gnawed their way backward quickly into the high peneplains or plateaus. Deep and even profound ravines were formed in this way. A visit to the Buffalo, Bogong, or Blue Mountains, or to the ravines of New England would impress the geographer with the power of streams to cut the plateaus to pieces. Similar fine examples of erosive action may be noted between Omeo and the summit of the Bogong Mountain, at Kosciusko, on the Blue Mountains, or at Guy Fawkes and the Macleay gorges, and on the plateaus around Cairns. The material which once filled these wonderful gorges and ravines has been deposited in part by the streams in the interior, thus forming the great plains of the Artesian, Murray, Darling, and other areas.

While the plains of accumulation extend in the central region, the grand peneplains, once with co-extensive surface from south to north of eastern Australia, are in places dissected beyond

recognition. Thus the plains are built up from the destruction of the raised peneplains. The death of the one is the life of the other. To decipher the story of the peneplains one must go into the central plateaus, for the intermediate areas tell very little.

5. SOME CHARACTERISTICS OF THE PLAINS AND PENEPLAINS

(a) Soils

(i) **Plains.** The deep soil of the plains of accumulation is black in those places where it is periodically flooded, and reddish or greyish where it is not subject to periodical and sustained flooding. Hence the deep alluvium of the river banks near the eastern plateaus is black, but the Riverina and the higher alluviums of the more arid west are reddish and greyish.

The soils of the plains of erosion may be of reddish sand arranged in long crests and troughs, as in the country extending far to the north of Broken Hill; they may be reddish or greyish as in the mallee and saltbush country of south-central Australia.

The red soil may exist in areas of aridity, semiaridity, or of heavy precipitation. Long spells of hot dry weather are sufficient to develop the colour, which is due to a form of iron oxide.

Greyish concretionary masses of travertine or impure limestone occur in the southern portion of South Australia, and elsewhere. This type, however, may be mainly referred to the soils of lowland peneplains.

(ii) **Peneplains.** Immense stretches of sandy or clay soil occur within the great plains of erosion or lowland peneplains of the centre which overlie or are in the vicinity of the Great Artesian Basin. Over extensive areas these are littered with pebbles, large and small, either formed as concretions in place or scattered as remnants of older conglomerates.

The soils of the plateaus have, in the main, been derived in place, and they indicate, generally, the nature of the surrounding rocks. Thus the extensive deep black and red soils of the high plateaus arise chiefly from the decay of basalts, andesites, some slate and allied rock types; the black soils occupying the areas subject to flooding, and the red and chocolate soils forming the drained hillsides. The hungry sandy soils originate from the decomposition of the Sydney sandstones and allied types and the sandy granites and quartzites, forming the older plateaus. The cold, hungry, and acid clays owe their existence to the decomposition in place of felsites, certain porphyries, and many Palæozoic slates, while the light loams arise from the decomposition of the darker granites, and from an intermingling of soils by stream action on dark and sandy rocks associated in the same district.

(b) Vegetation

The flowering plants of Australia have caused more discussion among students of plant distribution, perhaps, than those of any other area of equal size. One hundred years ago travellers to Australia were besought to bring "home" seeds of the plants peculiar to Australia. To the botanists of that period the strange appearance of the Australian types was referred to a special creation, but the explanation thereof is simple enough if studied in connection with the remarks in the preceding section.

When Australia became isolated, as stated above, the great families of the flowering plants of the world were all represented within the island continent. These included the myrtle, the daisy,

heath, geebung, pea and bean, acacia, euphorbia, citrus, cassia, labiate, umbellate, and many other families, but once cut off from intercourse with the same types in the other continents they became modified in Australia to meet the climatic changes which were being ushered in about the time of isolation. These climatic changes were in the nature of recurrent and increasing dryness, and hence arose in Australia a dominant type of xerophytic plant, one which had to contend either with a drying atmosphere or with conditions which do not yield a generous supply of moisture to the plant.

Hence arose the eucalypts, the leafless type of acacia, the geebungs, the waratah, the needle wood, the oak, the quandong, the Christmas bush, the wild currant, the five earner, the native pear, the porcupine grass, and many others.

Strange as it may seem, it was not the deep black and red soils of the plains which the plants found most suited for their preservation. After much experiment they reached their maximum development as individuals, species, genera, and families on the hungry sandy soils of the peneplains and dissected peneplains. Splendid examples of this development are to be found around Sydney, the Blue Mountains, the lower Clarence hills, and the country from Perth to Albany.

These soils were light and porous, and were not subject to hard baking in drought time.

Herbs were not in such great abundance in those days of development as they are now, and most of the flowering plants of the period prior to the Australian isolation were handsome, luxuriant shrub and tree growths. Even the aster, the groundsel, the veronica, the bignonia, and other types were small woody shrubs or large trees.

Thus the great groups of the myrtles, the tree legumes, the rue, the proteads, the euphorbias, the labiates, the heaths, the lilies, the saxifrages, and others developed the wonderful assemblage of plants peculiar to Australia on the sandy peneplains of eastern and western Australia. In vain does one search for other than traces of these strange assemblages on the deep alluvium of the plains.

There were **some** herbaceous types in those days, and from them sprang the wonderful and peculiar terrestrial orchids, the lily-like types, the iris, amaryll, grass, reed, and rush types of the sandy plateaus and coastal plains.

The vegetation of the inland peneplains and plains differs materially from that of the well watered plateaus and coastal areas.

The tree types survived in great measure even on the subarid to arid centre, especially types such as the leafless **Acacia**, the dog or sandal wood, needle wood, quandong, oaks, and a few eucalypts, but the herbaceous and undershrub types became dominant.

Thus the family of the beets and docks (saltbush, blue bush, Kochias, Bassias, Enchylænas), that of the Myoporaceæ (teaplant of the west, the Buddha, turpentine, kangaroo bush, sandalwood, and so on), allied to the verbenas, the herbaceous legumes (Darling pea, gilgai pea, desert pea, the **Swainsonas**), the crucifers, the composites (ever lastings, sifting bushes, asters, and so on), the Zygophyllums, and certain grasses became the dominant types.

The myrtles, heaths, the proteads, the rue, and the woody pea plants, which are the glory and marvel of the sandy peneplains and coastal plains, are conspicuous by their absence on the great inland plains, save for a few hardy eucalypts along the plain water-courses and the deep sheltered valleys, a couple of oaks, a needle wood, a beef wood, and a leopard wood.

On the great north-western plains in the spring of 1903 the marsh-mallows and the variegated

thistles were as much as 10 to 12 feet high in places, and the trefoil and other edible herbs made a tangle over knee deep to the limit of vision. Flowers of all shades sprang into being by hundreds of millions, making the plains like a gigantic carpet, beautiful as the finest heath-covered wolds. One week the blue flowers predominated, later it was a mosaic of yellow, red, and white. In the great plains beyond Broken Hill in 1918 the gentle slopes were covered with flower associations of indescribable beauty. White and yellow everlasting flowers in countless millions formed the general setting, while amid these shone the red tips of the spiked bassias and the quaint grey of the small saltbush types.

(c) Animals

Both peneplains and plains abound with animal life. As with the plants, so also the fauna of these regions is specially adapted to its environment. Even the arid plains, so called, teem with life.

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